

Interactive comment on “Greenland annual accumulation along the EGIG line, 1959–2004, from ASIRAS airborne radar and detailed neutron-probe density measurements” by T. B. Overly et al.

Anonymous Referee #1

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Overly et al. present an analysis of annual snow accumulation for the period 1959 to 2004 along a 250 km segment of the EGIG line in the dry snow zone of the Greenland Ice Sheet. They derive the depth of annual accumulation layers below the surface from measurements of the airborne radar altimeter system ASIRAS acquired during the CryoSat Validation Experiment (CryoVEx) 2006 campaign of ESA. For converting the thickness of radar layers to values of annual accumulation they use density profiles measured by neutron-probe down to 11 m depth at several points along the line and for greater depths extrapolated densities from ice core data. The retrieved accumulation

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shows significant increase for the last ten years of their investigation period compared to previous years, in agreement with in situ point measurements in this area. Complementary to the point measurements, ASIRAS data provide high spatial detail of layer depth and derived accumulation along the transect. The analysis reported in the paper includes a comparison with snow accumulation output from the Polar MM5 mesoscale model, showing underestimation of accumulation by MM5 compared to ASIRAS derived values. The paper presents new information on methods for retrieving accumulation rates from radar layers and on accumulation history in the study region. It is well written and clearly organized. Still, there are some issues, addressed below, for which further information/discussion should be provided.

Retrievals of snow accumulation along the EGIG line using ASIRAS data have been reported before in two publications. Hawley et al. (2006) evaluated annual snow accumulation rates for 1995 to 2002, delaPena et al. (2010) for 1998 to 2003. Both studies used data of the CryoVEx 2004 campaign. The work by Overly et al. covers a longer period, being of great interest for studying the impact of changing climatic conditions on accumulation. The last 10 years are not yet covered. There have been further ASIRAS data acquisitions in 2008, 2011, and 2012 over the same area which should be mentioned. In particular, Simonsen et al. (J. Glaciol., Vol. 59(215), 2013, pp. 545; not cited in the manuscript) report on the analysis of ASIRAS data from CryoVEx 2006 and 2008 campaigns over the EGIG transect and other sites in Greenland, addressing issues of firn compaction, etc. This paper is very relevant for the work presented by Overly et al. and should be referenced accordingly.

The ASIRAS signal analysis of Overly et al. traces annual layers to significantly greater depth than reported by Hawley et al. (2006) and delaPena et al. (2010). Simonsen et al. show for the EGIG line annual layers down to 15 m depth. In Section 3.1 the authors present processing methods for ASIRAS data. Differences and advancements versus the previously applied methods should be clearly explained. Another technical issue, not addressed in the paper but of potential interest to the reader, are possible

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links between the work presented in this paper and the application of CryoSat-2 data for retrieving accumulation rates.

The Polar MM5 model has been selected for the comparison between ASIRAS based accumulation with mesoscale model output (Sections 4.3, 5.3). High resolution accumulation data as provided by ASIRAS are of interest for validating regional climate models (RCMs). The Polar MM5 output shows consistent underestimation of accumulation compared to ASIRAS accumulation data (which agree with in situ measurements). This example is of limited relevance for assessing the performance of RCMs over Greenland, because it refers to one particular model and covers only a small section of the ice sheet. Additional comparisons with output from other RCMs (e.g. RACMO-2, HIRHAM-5) would provide wider evidence at least for the study region.

Interactive comment on The Cryosphere Discuss., 9, 6791, 2015.